

REMARKS

Applicants thank the Examiner for the thorough consideration given the present application. Claims 1-9, 11, 15, 16 and 18-40 are currently being prosecuted. The Examiner is respectfully requested to reconsider his rejections in view of the amendments and remarks as set forth below.

Rejection under 35 USC 112

Claims 1 and 14 stand rejected under 35 USC 112, second paragraph as being indefinite. This rejection is respectfully traversed.

Regarding claim 1, the Examiner points out that there is no prior description of impurities formed on the dielectric layer. Regarding claim 14, the Examiner points out that the bonding is not previously described. By way of the present amendment, claim 14 has been cancelled, rendering this part of the rejection moot. In regard to claim 1, the claim has been amended to describe the formation of the impurities. Accordingly, this rejection is believed to be overcome.

Rejection under 35 USC 103

Claims 1-33 stand rejected under 35 USC 103 as being obvious over WU et al., U.S. Patent 6,013,581 (hereinafter WU 1), in view

of WU et al., U.S. Publication No. 2003/0022513 A1 (hereinafter WU 2). This rejection is respectfully traversed.

The Examiner points out that the WU 1 reference shows a method to form a damascene structure having a metal layer, a cap layer, a dielectric layer on the cap layer, etching the dielectric layer to form an opening, providing a plasma treatment, and filling the hole with a second metal. The Examiner admits that the WU 1 patent fails to teach that the etching process includes a plasma process using fluorine containing plasma. The Examiner cites WU 2 to show etching the dielectric layer with a plasma etch using fluorine containing plasma to remove impurities from the dielectric layer. The Examiner feels that it would have been obvious to enable the etching process of WU 1, according to the teachings of WU 2. The Examiner also admits that the combined teachings of WU 1 and WU 2 fail to teach plasma treatment for repairing a bond between the first metal layer and a dielectric layer.

Applicants have amended the claims to now point out that the dielectric layer overlies a first metal layer, and that the etching step forms the opening to expose the first metal layer, which causes impurities to be formed. The plasma treatment is then performed on the metal layer to remove the impurities. Figs. 3A-3C show that the dielectric layer 20 overlies the metal layer 10, and that the etching step exposes the metal layer. The specification has been amended on pages 8 and 9 to specify this more completely.

WU 1 does not discuss performing the plasma treatment on the metal layer to remove impurities. Instead, col. 3, lines 37-41 state that the plasma treatment is performed on the surface of the dielectric layers 206 and 210. Likewise, col. 3, line 66 - col. 4, line 3, states that the plasma treatment causes the material to fuse into the partial surface of the dielectric layers to densify the surface. Thus, this reference does not describe any treatment on the first metal layer as is presently claimed. Instead, the reference teaches treatment on the dielectric layers. Further, this reference actually teaches away from the present invention, since the plasma treatment is used to densify the dielectric layers rather than to remove impurities on the metal layer. In the present application, the plasma treatment is performed on the metal layer to remove impurities and repair the binding between the metal layer and the dielectric layer to prevent dielectric peeling, stress migration and electro-migration.

Furthermore, WU 2 shows a polymer debris pre-cleaning method, in which a pre-cleaning process is performed by plasma after an etching process. However, WU 2 does not teach a plasma treatment on the metal layer to remove impurities. Thus, the combination of WU 1 and WU 2 still does not teach this feature. Accordingly, WU 2 also teaches away from the present invention, since it does not teach the concepts of applying the plasma treatment to the metal layer.

Furthermore, Applicants submit that there is no motivation to combine the two teachings. Since WU 1 discloses a plasma treatment to densify the dielectric layer and WU 2 teaches a plasma treatment to remove polymer debris, it would not be obvious to one of ordinary skill in the art to combine the two teachings.

Thus, neither of the references teaches or suggests the claimed feature of performing a plasma treatment on a metal layer to remove impurities. Further, there is no motivation to combine the functions. Thirdly, there is no expectation of success, since there is no evidence that the plasma treatments of either reference can remove impurities on the metal layer. Accordingly, Applicants submit that claim 1 is allowable over this combination of references.

Independent claims 18 and 26 recite similar recitations to claim 1, and are allowable also for the same reasons as cited above.

Claims 2-9, 11, 15, 16, 19-25 and 27-33 depend from these allowable independent claims and, as such, are also considered to be allowable. In addition, each of these dependent claims recite additional features of the invention which make them additionally allowable. Accordingly, these claims are also considered to be allowable.

Claims 34-40 stand rejected under 35 USC 103 as being unpatentable over WU 1 in view of WU 2, and HUANG, U.S. Publication No. 2002/0054962 A1. This rejection is respectfully traversed.

The Examiner admits that the combined teachings of the two WU references fail to teach that the photoresist contains carbon. The Examiner relies on HUANG to show the use of organic photoresists as part of the patterning process. However, Applicants submit that, even if this reference does show this feature, that the combination of the two WU references and HUANG still fails to show the plasma treatment on a metal layer to remove impurities. HUANG teaches a plasma treatment following the deposition of a layer rather than following etching, as is presently claimed. Thus, HUANG teaches away from the present invention. Further, Applicants submit that the three-way combination is even less obvious than the two-way combination described above. Accordingly, Applicants submit that independent claim 34 and dependent claims 35-40 are also allowable.

Conclusion

In view of the above remarks, it is believed that the claims clearly distinguish over the patents relied upon by the Examiner, either alone or in combination. In view of this, reconsideration of the rejections and allowance of all claims are respectfully requested.

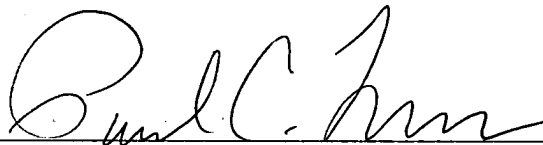
In the event that any outstanding matters remain in this application, the Examiner is invited to contact the undersigned at (703) 205-8000 in the Washington, D.C. area.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. §§ 1.16 or 1.17; particularly, extension of time fees.

Respectfully submitted,

BIRCH, STEWART, KOLASCH & BIRCH, LLP

By



Joe McKinney Muncy, #32,334


for

P.O. Box 747

Falls Church, VA 22040-0747

(703) 205-8000

#43,368

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